ASSOCIATED RESEARCH, INC.

# OPERATION AND SERVICE MANUAL

MODEL 412AI

AC HYPOT® JUNIOR

SERIAL NUMBER 6099

ASSOCIATED RESEARCH, INC.
905 CARRIAGE PARK AVENUE
LAKE BLUFF, IL 60044 U.S.A.
PHONE 1 (708) 295-3312
FAX: 1 (708) 295-9165

FOR TECHNICAL ASSISTANCE
PHONE: 1 (800) 858-TEST

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# OPERATORS MANUAL

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## INTRODUCTION

This manual discusses the reasons why dielectric withstand tests are required, the precautions necessary to ensure that tests are done safely, and how such tests are accomplished on various classes of materials, components and products.

In later chapters, the features of Associated Research 400AI series Hypots® Jr. are explained, along with a step by step guide to its proper use. Finally, technical data on all models is presented.

## SAFETY PRECAUTIONS REQUIRED FOR HIGH VOLTAGE TESTING

**WARNING:** A Hypot® Jr. produces voltages and currents which can cause **harmful or fatal electric shock.** To prevent accidental injury or death, these safety procedures must be strictly observed when handling and using the test instrument.

### SERVICE AND MAINTENANCE

User Service
To prevent electric shock do not remove the instrument cover. There are no user serviceable parts inside. Refer servicing to an Associated Research, Inc. authorized service center. Schematics, when provided, are for reference only.

Service Interval
The instrument and its power cord, test leads, and accessories must be returned at least once a year to an Associated Research authorized service center for calibration and inspection of safety related components. Associated Research will not be held liable for injuries suffered if the instrument is not returned for its annual safety check and maintained properly.

User Modifications
Unauthorized user modifications will void your warranty. Associated Research will not be responsible for any injuries sustained due to unauthorized equipment modifications or use of parts not specified by Associated Research. Instruments returned to Associated Research with unsafe modifications will be returned to their original operating condition at your expense.

### TEST STATION

Location
Select an area out of the main stream of activity which employees do not walk through in performing their normal duties. If this is not practical because of production line flow, then the area should be roped off and marked for HIGH VOLTAGE TESTING. No employees other than the test operators should be allowed inside.

If benches are placed back-to-back, be especially careful about the use of the bench opposite the test station.

Power
Dielectric Voltage Withstand Test Equipment must be connected to a good ground. Be certain that the power wiring to the test bench is properly polarized and that the proper low resistance bonding to ground is in place.

Some testers incorporate monitor circuit which check the connections to the power line and ground. The lights on these line monitors show at a glance if the wiring is correct or if the

polarity is wrong, ground missing, etc. If the line monitor show a fault condition, turn off and unplug the tester and do not use it until the wiring is repaired.

Power to the test station should be arranged so that it can be shut off by one prominently marked switch located at the entrance to the test area. In the event of an emergency, anyone can cut off the power before entering the test area to offer assistance.

Work Area

Perform the tests on a nonconducting table or workbench, if possible. If you cannot avoid using a conductive surface, be certain that it is securely grounded to a good earth ground and insulate the high voltage connection from the grounded surface.

There should not be any metal in the work area between the perator and the location where products being tested will be positioned. Any other metal in the work area should be connected to a good ground, never left "floating".

Position the tester so the operator does not have to reach over the product under test to activate or adjust the tester.

Keep the area clean and uncluttered. All test equipment and test leads not absolutely necessary for the test should be removed from the test bench and put away. It should be clear to both the operator and to any observers which product is being tested, and which ones are waiting to be tested or have already been tested. Do not perform Hipot tests in a combustible atmosphere or in any area where combustible materials are present.

**TEST OPERATOR**

Qualifications

This instrument generates voltages and currents which can cause **harmful or fatal electric shock** and must only be operated by a skilled worker trained in its use.

The operator should understand the electrical fundamentals of voltage, resistance, and current. They should recognize that the test instrument is a variable high-voltage power supply with the return lead directly connected to earth ground and therefore, current from the high-voltage output will flow through any available ground path.

Safety Procedures

Operators should be thoroughly trained to follow these and all other applicable safety rules and procedures before they begin a test. Defeating any safety system should be treated as a serious offense and should result in severe penalties, such as removal from the Hipot testing job. Allowing unauthorized personnel in the area during a test should also be dealt with as a serious offense.

Dress
Operators should not wear jewelry which could accidently complete a circuit.

Medical Restrictions
This instrument should not be operated by personnel with heart ailments or devices such as pacemakers.

**TEST PROCEDURES**

**!NEVER PERFORM A HIPOT TEST ON ENERGIZED CIRCUITRY OR EQUIPMENT!**

Connect the return (ground) lead **first** for any test regardless of whether the item under test is a sample of insulating material tested with electrodes, a component tested with the high voltage test lead, or a cord-connected device with a two or three prong plug.

Plug in the high voltage test lead only when it is being used. Handle its clip only by the insulator-**never touch the clip directly.**

Be certain that the operator has control over any remote test switches connected to the Hypot®Jr.

Before turning on the Hypot®Jr., rotate the voltage control to its maximum counterclockwise position. Double check the return (ground) and high voltage connections to be certain that they are proper and secure.

**Never touch the item being tested or anything connected to it during the Hipot test.**

At the end of a test, once again rotate the voltage control to its maximum counterclockwise position and check the meter to be sure the voltage across the item under test has dropped to zero before disconnecting the test leads. When testing with DC, always discharge the capacitance of the item under test and anything the high voltage may have contacted-such as test fixtures-before handling it or disconnecting the test leads.

HOT STICK probes can be used to discharge any capacitance in the item under test as a further safety precaution. A hot stick is a nonconducting rod about two feet long with a metal probe at the end which is connected to a wire. To discharge the device under test, two hot sticks are required. First connect both probe wires to a good earth ground. Then touch one probe tip to the same place the return lead was connected. While holding the first probe in place, touch the second probe tip to the same place where the high voltage lead was connected. Again, check the meter to be sure the voltage has dropped to zero.

## WHY PERFORM DIELECTRIC WITHSTAND TESTS?

A dielectric withstand test is a deliberate application of a higher-than normal potential across some insulating material or the entire insulation system of a component or device. This stresses the insulation and the intent is to verify that the insulation can take this stress without breaking down and allowing arcing, and without drawing excessive current. If the insulation passes the test, it is assumed that it will withstand the lesser stress of its intended application. The test can uncover defects in material or workmanship which would render the insulation system ineffective if not corrected.

The items most commonly subjected to dielectric withstand tests fall into four categories:

I. Insulating raw materials: solids, liquids, gases.

II. Components: switches, relays, transformers, circuit breakers, potentiometers, wire, cable, connectors, etc.

III. End Products: appliances, motors, instruments, office machines, the control equipment of aircraft, machine tools, etc.

IV. Repaired or rebuilt products: rewound motors, generators, transformers, repaired appliances and entertainment devices, etc.

The majority of the tests performed can be grouped into the following categories:

I. Design Tests: A manufacturer desiring to verify the insulation provided by a supplier or designed into his product may run tests in a laboratory environment. Such tests may be designed to stress insulation or insulation systems against either the supplier's or the manufacturer's own specifications, or during component selection to gauge the relative insulation quality of competing products.

II. Routine Production Tests: A manufacturer may conduct tests at various points in the production of his products to uncover defects in material or workmanship and prevent the defective product from receiving further processing.
Often a regulatory agency or independent testing lab will require specific tests on completed products immediately prior to packaging for shipment. The products must pass these tests as a condition for "listing" or "recognition" or "certification" or even for permission to offer the product for sale.

III. Acceptance Tests: A purchaser may conduct tests on purchased components to prove that they meet minimum insulation specifications, to prevent faulty components from being incorporated into his own products.

IV. Service or Maintenance Tests: The owner of a piece of equipment may wish to periodically verify the integrity of its insulation system,to determine whether or not deterioration has taken place, and to what extent. A rebuilder of motors, etc., may wish to verify that his work was done properly by performing tests on the rebuilt equipment. A repairer of appliances, entertainment devices, etc., may wish to verify that he has not degraded the insulation system of any item he has repaired and to give the owner some minimum assurance of safety.

## TYPICAL APPLICATIONS

To insure that the insulation or insulation system is properly stressed during a dielectric withstand test, the voltage must be applied across the insulation. This would not be the same connection as is normally used to power up the device being tested. For each of the categories of items mentioned earlier, we will discuss the usual application of the test potential:

I. Insulating raw materials: In general, the test voltage is applied to the test sample by placing the sample between two metallic electrodes connected to the Hypot® output. Of course, the size and shape of the electrodes must be proper for the type and amount of material being tested, and for testing liquids or gases, suitable containers must also be used.

II. Components: Most often the tests required for components test the insulation between parts which are normally conducting and parts which are normally isolated and non conducting or grounded. For example, in testing a potentiometer, the three potentiometer terminals would normally be shorted together and connected to the high voltage lead, and the case of the potentiometer would be connected to the ground lead. Sometimes, as in the case of transformers and motors, additional tests are required between normally conducting parts which must be kept insulated from each other. A simple transformer, for example, would receive three tests: primary to frame secondary to frame, and primary to secondary. When testing transformers, it is common and recommended practice to tie both ends of a winding together before applying one side of the high voltage. It is not the continuity of

the winding which is being tested, but the insulation from every part of the winding to other components of the transformer. Similar treatment is usually given any winding, coil or heating element in a component, because over-voltaging these parts is not generally part of the Hipot test. Switches and relays, in addition to being tested from conducting parts to dead parts, are often also tested across open contacts. A special electrode may be required to test resistors, capacitors and similar items when it is desired to test the insulation provided by a coating or molded case. The special electrode, touching the outside of the case, is one connection point. The other is the leads of the device, all shorted together.

III. End products: These are typically cord-connected finished products. The double-insulated variety must be tested with special electrodes touching the outside of the case connected to one side of the Hypot®Jr. and both blades of the line cord connected together and to the other side of the Hypot®Jr. Any device with metal parts on its exterior should have the return (ground) lead connected to those metal parts (all connected together at once, or sequentially) and the high voltage applied to both blades of the line cord shorted together. For any testing of cord-connected end products, always leave the power switch(s) on so that the entire line circuit will be tested. If the device does not have a neutral connection, and the ground connection normally, carries current, it will fail a Hipot test from line to ground unless the connection from the internal wiring to ground is temporarily lifted during the test. Combination 240-120V appliances are often of this nature.

IV. Repaired or rebuilt products: The same techniques are generally used as on new equipment, except that the test voltage or time is sometimes reduced. The voltage used and the time for which it is applied are sometimes specified by the manufacturer of an insulating material or by a regulatory or testing agency. When they are not, the following "rule of thumb" is often used: determine the voltage(s) in the circuit(s) being tested, under normal operating conditions. For a circuit to circuit test, as in a transformer, the voltage will depend on the degree of isolation required between circuits. For a circuit to ground or circuit to dead metal test, use two times the normal voltage plus 1000V. For example, a household iron rated at 120V would normally be tested at 1240V.

## TESTING CAPABILITIES

The actual leakage current of most items varies from a few microamps to several milliamps. When the item under test presents a primarily resistive load, it may be handled without difficulty by almost any of the HYPOT JUNIOR models. Then the question is one of selecting the HYPOT on the basis of the output voltage desired. However, where the physical size of the unit increases, and particularly if motors are present, the distributed capacitance between the conductors and ground increases rapidly so that a point is reached where the current, due to this capacitive reactance exceeds the output capabilities of the HYPOT® JUNIOR. When this condition is reached, the output voltage cannot be built up to the proper value and the leakage light will glow very brightly. In extreme cases of very high capacitance, the HYPOT® JUNIOR will act exactly as if the output were short circuited, but the inherent current limiting feature of the instrument will prevent any detrimental effect. For example, a large AC motor may draw a charging current as high as several hundred milliamps at a test voltage of 2500 volts, due to the high distributed capacitance of the windings. If a HYPOT® JUNIOR were connected between windings and frame of such a motor, no output voltage could be obtained and the leakage light would indicate a short circuit.

As a rough guide to the typical range of capacitance of manufactured items frequently tested with HYPOT® JUNIOR, the following table is supplied.

| EQUIPMENT | APPROXIMATE CAPACITANCE IN MICRO-MICROFARAD |
|---|---|
| Hair clippers 115 volt, 60 cycle, 15 watt | 70 |
| Polyphase induction motor, 5 H.P. 350 volt, 60 cycle, 3 phase | 2500 |
| Single phase, capacitor starting, induction run motor, 1 H.P., 115/230 volt, 60 cycle | 850 |
| Single phase, capacitor starting, induction run motor, 1/6 H.P., 115 volt, 60 cycle | 700 |
| Single phase, shaded pole induction motor, 11.5 watts, 115 volt, 60 cycle | 100 |
| Universal (series) motor, 115 volt, AC/DC, 2.5 ampere | 215 |
| Hand drill, 115 volt AC/DC, 1.3 ampere | 285 |
| Bell ringing transformer | 100 |

| EQUIPMENT | APPROXIMATE CAPACITANCE IN MICRO-MICROFARAD |
|---|---|
| Toy transformer, 75 watt, 60 cycle | 150 |
| Low rate type battery charger, 6 volts, 4 ampere DC output | 200 |
| High rate type battery charger 7/14 volts, 100/80 amperes | 1000 |
| Soldering gun 115 volts, 60 cycle, 200 watt | 175 |
| AC tap type arc welder 100 amp, 25 volt output | 400 |
| Radios | 50,000 |
| Television sets | 50,000 |
| Enclosed switch, 3/4 H.P., 30 ampere, 115/230 volt AC | 60 |
| Circuit breaker, 30 ampere, 115/230 volt | 10 |
| Solenoid coil of magnetic starter, 550 volt 60 cycle | 100 |
| Solenoid coil of valve, 115 volt, 60 cycle, 6 watt | 100 |

It is evident from the above that an extremely wide range of items can readily be tested with HYPOT® JUNIORS, even including 5 H.P. inductions motors. The only item tested that would probably represent borderline cases would be the radios and television sets.

## FEATURES OF MODELS 404AI, 411AI, 412AI, 414AI, 422AI, 411AAI, 412AAI, 414AAI, 422AAI

1. Wide, easily read 4-1/2 inch AC kilovoltmeter with 2% of full scale accuracy.

2. Detachable 5 foot return (ground) lead. This lead is always used in performing tests and is grounded for safety.

3. Detachable 5 foot high voltage lead with flexible silicone rubber insulation for easy handling and user safety. Control panel jacks are well recessed for safety.

4. Lighted rocker switch on the control panel which indicates "power on" and that the High Voltage circuit is energized.

5. Lighted leakage indicator. If excessive current is drawn during the Hipot test, the yellow leakage indicator will illuminate and an audio alarm will sound. To reset the unit, simply decrease the output voltage to zero, place the power switch into the "Off" position and remove whatever is causing the failure from the output leads.

6. The breakdown indicator is responsive to a broad band of RF frequencies such as those generated when breakdown or arcing across insulation takes place. Since this light is only sensitive to RF currents, it will not normally indicate when the equipment under test is short circuited or when high leakage currents are present, but will indicate any time there is actual sparking, arcing or corona. On the other hand, since arcing is normally associated with relatively high currents, the leakage light will usually indicate simultaneously with the breakdown light. If the output voltage of the HYPOT® JUNIOR is raised to a high value and then the connection is made to the equipment under test, the breakdown light will sometimes flicker. This does not necessarily indicate an actual breakdown, but usually is due to the fact that as the hot lead is brought to the equipment, there is a point reached where the air gap separating the test lead from the equipment is decreased sufficiently to permit current flow by arcing through the air. Once physical contact is established, the arcing ceases (assuming no breakdown of the equipment). This arcing is therefore normal to the establishing of the circuit, and does not in itself indicate any breakdown in insulation.

7. Voltage adjust knob. This control varies the high voltage from near zero to the full AC voltage. The voltage can be adjusted only when the high voltage circuit is energized. It is recommended that the voltage control be returned to zero at the end of each test.

WARNING: Since the high voltage circuit of all these models is energized whenever the unit is turned on, it is possible that as much as the full output voltage will be present at the output terminals if the voltage control is not at its extreme counter-clockwise position.

8. Detachable 7-1/2 foot power cord with standard connector.

9. Line fuse accessible from the rear. "Shock safe" fuseholder.

10. Current Trip (sensitivity) adjustments accessible through the back panel. The current at which the failure alarm will trip is adjustable from approximately .3mA to 5mA AC. Turn the controls counter-clockwise to decrease the current setting and increase sensitivity. Turn it clockwise to increase the current setting and decrease the sensitivity.

## 400AI SERIES HYPOT®JR. OPERATING INSTRUCTIONS

WARNING: DANGER - HIGH VOLTAGE -improper grounding or careless handling of the test set could result in dangerous shock hazard. Use extreme caution when operating.

1. Locate the Hypot® Junior in a suitable area for performing tests. There should be adequate light and power available. Allow sufficient room for the devices to be tested in such a way that the connections to them will be straightforward and uncrowded and all personnel will be able to stay clear during the tests. The surface upon which the tests will occur should be of a non-conductive material. If a conductive surface must be used, it should be securely electrically tied to a good earth ground and the high voltage connection will need to be properly insulated from ground.

2. Be sure the power switch is in the "Off" position.

3. Install and connect the line cord.

4. Connect the return lead to the Hypot® Junior and to the item to be tested.

5. Connect the high voltage lead to the high voltage output of the Hypot®Junior as required and to the item to be tested.

6. Rotate the Voltage Control of the Hypot® Junior fully counter-clockwise. This adjusts the high voltage output to near zero when the test set is energized.

7. Place the power switch into the "on" position to energize the high voltage circuit. Do not handle the test leads or touch the item under test once the high voltage circuit is energized.

8. Rotate the voltage control of the test set clockwise while observing the kilovoltmeter until the desired test voltage is indicated. Start timing when the proper voltage is reached. If there has been no failure indication at the end of the timing period, the item under test has passed.

9. Rotate the voltage control fully counter-clockwise.

10. Place the power switch into the "Off" position.

11. By observing the kilovoltmeter, verify that the high voltage has dropped to zero before disconnecting the item under test.

12. If the total test voltage can be applied instantaneously, the voltage control may be left at the proper setting and testing can be accomplished by placing the power switch to the "on" position after the connections to the item under test have been made and the test area is clear. Monitor the voltage on the kilovoltmeter as high voltage will energize and remain on until turned off by the operator. If the voltage must be applied gradually, steps 8 and 9 must be repeated.

13. If a test item failure occurs (excessive leakage current or break down [arcing]), the failure detection system will instantly indicate the nature of the failure by illuminating either the leakage or breakdown lamps and activating an audible alarm. Both the visual and audible indications will remain active and conspicuous until the failure conditions are removed from the output of the Hypot®Junior.

14. Always place the power switch into the "Off" position before connecting or disconnecting a test item.

WARNING: FAILURE TO DO SO MAY RESULT IN A DANGEROUS SHOCK HAZARD WHICH WILL SHOCK, BURN OR CAUSE DEATH.

## CURRENT TRIP (SENSITIVITY) ADJUSTMENT
(0.3mA to 5mA range)

The failure detection systems all 400AI Series Hypots® Jr. have been preset so that at 1mA, or more of output current, the alarm will sound and the leakage lamp will illuminate. If this factory setting is not appropriate for the intended application, it can be reset as follows:

1. Select a value of resistance which must trigger the failure circuit of the Hypot® Junior. The value of the resistance may be determined using the following formula:

   Voltage at which the test is being made = Value of Resistance
   Minimum current which must trigger failure.

2. Place the power switch of the Hypot® Junior into the "Off" position and rotate the voltage control to its extreme counter-clockwise position.

3. Connect the test leads to the Hypot® Junior output receptacles.

4. Connect the resistance chosen in step #1 across the test leads of the Hypot® Junior. The surface on which the test set is located should be non-conductive. If conductive, the surface must be grounded securely and the test leads isolated from ground.
5. Place the power switch of the Hypot® Junior into the "On" position.

6. Rotate the voltage control of the test set clockwise while observing the kilovoltmeter until it indicates the voltage used in selecting the resistance value in step #1. If the Hypot® Junior indicates a failure before the test voltage is reached, the current sensitivity setting is too low. The current trip adjustment located on the rear panel must be rotated either clockwise to decrease the sensitivity, or counter-clockwise to increase the sensitivity setting.

7. When the failure detection system is activated, rotate the voltage control counter-clockwise until the failure is automatically canceled.

8. Recheck the setting of the failure detector by slowly rotating the voltage control clockwise while observing the kilovoltmeter. The failure detector should be activated when the proper test voltage is reached. If not, repeat steps # 6 through 8.

9. Return the voltage control to its extreme counter-clockwise position and place the power switch into the "Off" position before disconnecting the test leads.

## SPECIFICATIONS

| | | |
|---|---|---|
| MODEL: | 412AI, 412AAI | |
| DESCRIPTION: | AC Hypot® Junior | |
| PRIMARY APPLICATION: | Laboratory evaluation of the dielectric strength of components, insulation systems, etc. | |
| INPUT: | 412AI | 412AAI |
| Voltage: | 115VAC | 230VAC |
| Frequency: | 50/60Hz | 50/60Hz |
| Phase: | Single | Single |
| Current: | 1 A | .5A |
| OUTPUT: | | |
| Voltage: | 0-1.5KVAC | |
| KVA: | 0.0075 | |
| Frequency: | 50/60Hz (same as input) | |
| Current | 5 mA AC | |
| Duty Cycle: | Continuous | |
| Failure Detector: | Current and arc sensitive failure system in return side of output. Continuously adjustable current sensitivity from .3-5 milliamperes. Factory set at 1 mA. | |
| VOLTAGE CONTROL: | Manualy operated, continuously adjustable from zero to maximum output. | |
| METERING KILOVOLTMETER: | Analog - 0-1.5KVAC with 50V reading resolution. | |
| TERMINATION: Input: | Detachable 7.5 foot 3 conductor power cable terminated in 3 prong grounding plug and IEC international connector. | |
| HIGH VOLTAGE: | Detachable five foot silicone rubber insulated cable terminated in clip with rubber insulation. | |
| RETURN: | Detachable five foot cable terminated in clip with rubber insulation. | |
| CABINETRY: | Portable type with handle - 10.825 X 9 X 5.825 inches. (274.95 X 228.60 X 144.95 mm) | |
| WEIGHT | 13.0 lbs. (5.9 Kg) | |

# REPLACEMENT PARTS LIST

To order replacement parts, refer to the Replacement Parts List on the following pages. If you need assistance, call our Technical Support Hotline 1-800-858-TEST.

# REPLACEMENT PARTS LIST

| SYMBOL | PART NO. | DESCRIPTION | QTY. |
|---|---|---|---|
| AL | 35520 | Alarm, Piezo | 1 |
| C1 | 35216 | Capacitor 2200 MFD. 25V | 1 |
| C2 | 35497 | Capacitor .0022 MFD. 200V | 1 |
| D1-3 | 35214 | Diode, 1N4001 | 3 |
| D4 | 35884 | Diode, Led Orange | 1 |
| D5 | 35767 | Diode, Led Yellow | 1 |
| D6,7 | 14503 | Diode, 1N4006 | 2 |
| F1 | 17755 | Fuse 1A Slo-Blo 3AG 250V | 1 |
| | 35458 | Fuse Holder | 1 |
| | 35457 | Fuse Carrier | 1 |
| J3 | 35665 | Conn. Fem. Polar Socket | 1 |
| J5 | 04040A-18 | Jack HV Assy. | 1 |
| J6 | 15495 | Jack Bannana Blk. | 1 |
| K1 | 35435 | Relay, Reed SPST | 1 |
| L1 | 11155 | Choke, Fxd. 2.5 MHF. | 1 |
| M1 | 00412AI-06 | Meter Assy. | 1 |
| P1,2 | 35473 | Conn. Male 3 Post HDR | 2 |
| P3 | 35670 | Conn. Male HDR Ribbon | 1 |
| P4 | 35492 | Recpt, Male 250V, 6A | 1 |
| R1 | 16123 | Resistor Fxd. 100 ohm, 1/2W, 1% | 1 |
| R2 | 17073 | Resistor Fxd. 316 ohm, 1/2W, 1% | 1 |
| R4,6,7 | 34878 | Resistor Fxd. 12.1 K ohm, 1/2W, 1% | 3 |
| R5 | 35495 | Resistor Var. 500K ohm, 2W, 10% | 1 |



over

# SCHEMATIC

MP MASTER
MA22962